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Seth Green
Father of Fish Culture

By SYLVIA R. BLACK

Background

Over 125 years ago, Adonijah Green, farmer, cleared the woods on the present site of Culver Road and Empire Boulevard. He had come here with his wife a few years before 1817, either directly from England or from the New England States, knowing that the rich earth of the Genesee country, bearing huge forests, could be made productive. Here he hewed the hard timber, which was abundant in the forest, and built his one-story, square, log cabin. It was a primitive home, with rough boards for a floor, a door fastened by a wooden latch with string, and a chimney made of sticks and plastered with clay. The many cracks were stuffed with sticks and clay to keep out the wind and rain. Two small square windows admitted light.

In this primitive home a son, Seth, destined to become famous, to meet with Presidents and to be honored by foreign countries, was born on March 19, 1817. Seth was trained very early in the ways of a pioneer farmer's son—how to sow wheat and corn and how to thresh the grain with flails. Seth learned quickly, and it was not long before Adonijah could rely on him to help trap the small animals so abundant in the forest, and to reel in a good-sized fish. During the winter, dressed in his warm buckskin breeches and flaxen shirts made by Mrs.

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Green on her own loom and spinning wheel, and with his feet safely secured by Indian moccasins, Seth would often stalk proudly through the forest beside his father in search of deer and other game for their dinner. Perhaps, unexpectedly, they would hear a hog scream in the distance, and Seth would know that a bear was after pork for his dinner. Then Seth and Adonijah would run quickly to match their wits against the bear's for the hog. Sometimes they were doubly rewarded, not only securing the hog, but the bear as well. On such evenings, lying on the floor near the blazing hickory fire on the hearth, Seth would watch his mother and father dress the bear's meat and put aside the hide for a rug. Later in the evening, Seth would be loath to leave the enveloping warmth and climb the ladder to his icy bed in the loft. In the summertime the young child, barefooted, as was Adonijah, could hardly wait to go fishing with his father, though the latter had less inclination for this work.

Life in the wilderness soon proved too much for the ambitious Adonijah. He was becoming heartily sick of the monotonous diet of game and tired of the hard, barren existence of a farmer. His wife was just as ready to leave the primitive cabin where she lived in constant terror of rattlesnakes, of sneaking wildcats, and treacherous wolves howling at her door, of the fever and ague that appeared to infest neighboring swamps. Undoubtedly she dreaded the cold winters with the snow piled high outside her door, and the wind howling through the chinks, blowing the door open and scattering snowflakes into the room. And most of all she must have suffered from the corroding misery of loneliness, for the Greens were several miles from the nearest neighbor or from any sort of community life.

Accordingly, one day when Seth was still a small boy, Adonijah, with his wife, two sons and two daughters, put their belongings into a wagon and started off to the thriving village of Carthage on the brink of the Genesee gorge about three miles north of Rochester.

Carthage was the name of a section situated on the east side of the Genesee River at the lower falls. Back in 1809, Caleb Lyon, a pioneer from the Adirondacks, had begun the slow task of clearing the land. In 1817 an ambitious young lawyer of Connecticut, Elisha B. Strong, passing through this Genesee country on his way to Canandaigua, became impressed by the superior advantages the site seemed

to possess and made arrangements with a few of his friends, Elisha Beach of Bloomfield and Heman Norton of New York City, to form a company for the purpose of buying this land from Caleb Lyon. The Strong Company, as the individual members decided to call this partnership, bought one thousand acres and prepared to build a flourishing community. Carpenters were brought from the East and in less than five years Carthage contained stately homes, prosperous stores, a post office, land offices, warehouses, flouring mills, steamboats, and stage hotels. Strong and Company laid out a public square, where other business men built their homes. A mill race was cut on the flats and a sawmill flourished.

One of the principal reasons for Carthage's rapid growth was its position on the Genesee River. Carthage Landing, as it was sometimes called, was one of the main docks from which ships, heavily laden with potash and leather, set forth for Canada and returned with Canadian goods. In the busy season one year five steamboats regularly touched at the Carthage Landing, a total of ten stops a week, and it was not unusual for as many as thirteen schooners at one time to be waiting to be loaded at the dock. Often as many as 100 barrels of flour were loaded on one boat, large amounts of groceries were shipped from Bell and Goodman's, Smith and Perkins', and other grocery stores.

Two taverns were already situated above the dock on top of the hill when Adonijah Green opened a third tavern at the Landing. The Pavilion, as the inn in which he installed his family was called, was by far the largest of them all. It faced south toward Carthage. On its back was a covered platform, from which Seth could stand and peer down the river as far as eye could see. It was fascinating to watch the steamers rounding the point as they made their way to the dock, to examine the shipping on the wharves, and to watch the cars on the double-track inclined railway which connected the upper and lower warehouses: when one car loaded with freight or passengers was ready to go down on one track, another car loaded with stone would go up the other. Many people preferred to walk down the stairs especially provided for timid souls.

It was a gay time there for the Green family. Adonijah had what he wanted: comfort, prosperity, and above all, a social life. All sorts of men came and went. Fishermen, sailors, and a good many derelicts

gathered around Adonijah's tavern to talk and drink and boast of various feats. Sailors about to leave for Canada invariably dropped into Green's tavern to drink to a happy voyage, and those returning would drink, too, and tell tales of their adventures.

Early Youth

Young Seth went about enjoying himself. His parents had sent him to the district school, a frame building near St. Paul and Norton Streets, but Seth left it after completing the fifth or sixth grade. The young child, with patches on his knees, his toes sticking out of his shoes, preferred to play with his friends, the Seneca Indians, who were still to be found around the settlement, especially at St. Paul Street and Hudson Avenue, where they had planted corn on a ten-acre lot, or just north of Carthage, where St. Paul Street and Ridge Road form a junction. It was at this latter place that Seth delighted to have bow and arrow contests and to stalk the surrounding woods for game with his Indian friends. They taught him to be observant of the slightest sound in the forest, and to be alert to its meaning. They developed in him the ability to coordinate his mental and physical faculties so completely that his response to the calls and sounds in the forest seemed almost instinctive.

Thus equipped, he became expert at hunting. The Seneca Indians also taught him the art of fishing, as well as the habits of fish. He himself invented ingenious ways of catching them, using common pins for fish hooks, which were the envy of all his playmates. But over and above all this elementary knowledge, Seth had characteristics which made him the superior hunter and fisherman that he later became. From his earliest days, he was quiet and observing. Seth's eyes were almost a living thing apart from his body. They were deep-set, sharp, and penetrating; they were animated by the intelligence and shrewdness of the boy. Unlike those who have eyes and see not, Seth had eyes and saw not only the surface of a situation or object, but through it, around it, and in perspective. As is likely to be true of all nature lovers and scientists in general, he had the ability to keep his attention centered on one problem and stick to it until he found a solution. From his own observations, too, he soon learned the ways of fish, the

right time of year, condition of wind and water, that they might be taken and the season for spawning.

So the boy grew, unhindered in his love for hunting and fishing, having no other burdens on his mind. His father's tavern prospered, and the family was happy.

Seth's unbounded freedom was shortlived, however, for the financial panic of 1837 hit Carthage quite hard. Although there was a temporary revival of business in 1838, when a proposal was made to construct a race from the lower falls to Carthage Landing, this scheme was not realized. Moreover, when the lease of Carthage's railroad expired, it was never renewed, and Carthage started on the road to oblivion. The promoters of Kelsey's Landing on the west side of the river, eager for the thriving business which Carthage had so long enjoyed, determined to improve Buell Avenue by cutting out an inclined road to the landing. Accordingly, they erected a grain elevator and a warehouse at the dock, constructed a hotel, and arranged to have an omnibus run from Rochester to the dock. Thus the new landing received all of the passengers going and coming from Canada and took most of its freight business away from Carthage.

When the twenty-year-old Seth sat on the river bank watching the men blasting out the new road, he realized that a change had come into his life and that he would have to provide for himself, for he could foresee how badly his father and mother would fare. Since he was so fond of fishing, it was only natural for him to decide to make fishing his trade. With the little money he had, he bought a net and started in earnest to fish under the lower falls.

There were all kinds of fish to be found in great abundance up the river as far as the lower falls: salmon, caught in scoop nets; catfish, weighing as much as 15 to 20 pounds were caught on night lines; sturgeon, weighing 150 pounds (called "Albany beef"), coming up the river in April and May, could be speared easily or caught with a hook and line. At this time there was an old distillery on the falls which was still in full blast, and when its refuse was thrown out, large numbers of bullheads were attracted to that spot. Seth, attracted there at night too, kept busy hauling in the bullheads to be skinned for market the next morning. The youth, very adept at this work, was

able to prepare two fish to the other fellow's one. Seth provided the sailing vessels with his hauls and saved every cent he earned.

Young Green, always friendly with the fishermen and sailors on the river, became the fast friend of a captain on one of the vessels sailing back and forth from Canada. One day this captain persuaded Seth to go with him on one of his trips to Canada. He was gone for two and one-half months on that particular trip, and the Carthage people spread it abroad that Seth had left the country for good. Even his own family had no idea where he was. But from this time forth, whenever Seth went on a trip to Canada, he was not expected back in less than a month.

The ambitious youth discovered that Canada contained excellent fishing places. Every year, from 1837 to 1840, he made a trip to Grafton, Ontario, for salmon entering Keeler's Creek. Here he met other fishermen who had hard and fast rules about fishing. The man who arrived first would build a fire and take the next arrival as his partner in the first run. None among these fishermen would disturb the salmon at the mouth of the creek, or take any at a distance from the shore. Even if a man picked up a dead fish he would be excluded from the group. The fishermen would start their first run just at twilight when the salmon were evident in all parts of the creek. Sometimes Seth was fortunate to be in the first run, but at times when he came late he often speared more salmon than his partner. Twenty minutes were required for each run, and at the end of the allotted time, Seth invariably had a huge haul, which he sold at five cents a pound when salmon was plenty.

Seth's Discovery

One day while fishing at Keeler's Creek, Seth noticed that the salmon, by their movements, were preparing their nests for their spawn. He became so fascinated by the sight that he climbed a tree which overlooked the river, so that he could observe their movements the better. He remained perched in the tree for two days, constantly watching the movements of the salmon. He found that as soon as the female fish cast her spawn, the male fish and other fish ate as much of it as they could find. The very few eggs that remained, the female

sedulously covered with gravel, in order to hide the eggs from the other fish. This act so amazed Seth that he fell to thinking about what he could do to prevent such waste in fish. It came to him, while he was perched there in the tree, that perhaps fish could be hatched artificially, and thereupon he resolved that sometime in the future he would try it.

So full of this discovery was Seth and so delighted that as soon as he returned to Carthage, he began observing other fish and making experiments, which years later brought fame and fortune.

Experimental Years

By 1848 Seth believed he had saved enough money from the sale of fish to embark on two ventures: he married Helen Cooke of Rochester and took his young bride to Front Street, where he had just opened a fish market. It was not long before Rochesterians could boast that Seth Green's clam chowder was the tastiest in the city. Here on Front Street Seth had ample opportunity to carry on his study of fish culture. With Monroe, his brother and partner, Seth also conducted experiments with spawning fish at a camp on a little island in the Genesee River below the lower falls. Seth had a good fish business on Front Street, but people were beginning to think he was acting somewhat queerly and was rather "notional" because of his experiments. Although they did not bother him, indulgent smiles greeted his accounts of success in hatching fish eggs.

Seth's fish business continued to increase to such an extent that by 1857 he became one of the largest dealers as well as one of the greatest fishermen in the state. He employed nearly one hundred men who caught and sold fish. He himself went out to catch fish with his men, using various kinds of nets and lines, and often rowing out in treacherous weather. There were times when Seth's boat capsized, forcing him to ride on the overturned bottom. One day Seth and a few of his men set out in an open boat at three o'clock in the morning to fish in Lake Ontario. They rowed for eighteen miles and four hours later reached their buoy. Soon a gale started up, which blew so hard that it broke Seth's fishing lines. He and his men started to row for shore, but after rowing for twelve hours, it was as if they had not budged

an inch. Seth kept encouraging his men with, 'Now, you are gaining it! Here's a lull, now bend to it,' until they reached Braddock's Bay, about three miles from his cabin, at three o'clock the next morning. The quantity of fish Seth and his men were able to haul in daily while he was in this thriving business varied from one-half to three tons.

Caledonia Fish Hatchery

By 1864, Seth was quite sure of himself. He was now a man in his late forties, with an expansive presence—not fat but stocky and of medium size. Despite his occupation, surrounded by the raw uncouthness and vulgarity which characterized fishermen and fish dealers, he possessed an innate refinement. Of medium height and weight, he had an unusual muscular development, betraying bodily vigor. A long, dark beard, sprinkled with gray, embraced a firm chin, while his deep-set, piercing eyes commanded attention and respect from his associates. He looked and acted like a superior person. He was shrewd, intelligent, and possessed an abundance of common sense, a sense of humor, and a far-reaching sympathy for all people.

It is not known exactly how much Seth Green gleaned from his predecessors about fish culture. Apparently, after watching from a tree the act of spawning on that fall day in 1837, Seth figured out for himself a technique for artificial fish propagation, working it out independently of anyone else. In 1842, Rémy and Géhin in France had worked through the same problem, but it is not likely that Seth read any of the very limited material on fish culture at that time. Moreover, Seth's plans differed entirely from his predecessors', who preferred to let their work on fish culture remain a subject for discussion and inconsequential experiments. He, instead, desired to put his knowledge to practical use. Accordingly, in the summer of 1864, Seth bought the exclusive right to the use of a long stretch of fishing grounds at Caledonia. Here he determined to raise brook trout for market, since all that he was able to catch could be sold in the Buffalo, Niagara, and Rochester markets for one dollar a pound. He had also in mind to raise fish for restocking public waters.

Caledonia, about seventeen miles from Rochester, was inhabited in 1864 by about one hundred people, mostly farmers. It was well

known, however, for its springs and creeks which contained huge numbers of fish. Springs are in abundance the entire length of Caledonia Creek, so that its waters remain at a constantly cold temperature, but never freeze. Its temperature range, from forty-five to sixty degrees, is advantageous for raising fish, especially trout. Another advantage lies in its waterfall, which is only about three feet high. Although its waters contain a very small amount of lime, they are free from pollution. The creek, fed by the Caledonia springs, discharges about 200,000,000 gallons of this very pure water in twenty-four hours. Any or all of it could have been used by Seth.

Near the water's edge, Seth built a small one-room house and several plain but substantial buildings to house his fish hatching apparatus. Numerous wooden tanks, a few hundred feet in circumference, were constructed in shallow pits with their tops built to the level of the ground. The water, containing fish of all sizes and weights, passed through these tanks. The fish were separated into sizes and kept in the tanks. Water was constantly gurgling in the tanks so that the fishes' environment would be the same as it would be in natural ponds.

Artificial Propagation

The performance of artificial impregnation is simple. The operator merely strips the female of her eggs, allowing them to fall into a pan. Then he causes the milt of the male to exude into the same pan. When the eggs are emitted, they are covered with a sticky substance, which hardens in about fifteen minutes after it has come in contact with the milt. In this stage they roll around on the bottom of the pan quite easily. Abouth one-eighth of an inch in diameter, they are translucent and vary in color from a pale straw to a rich salmon. Their outer coating is tough, and its content liquid. In this state they are immediately placed on the hatching beds under a constant stream of water. After forty days, it is possible to detect the eyes of the fish under a strong magnifying glass. After a time the body takes shape, but the head and eyes still seem out of proportion. Trout hatch in about 160 to 165 days, while it takes whitefish about 10 or 20 days less. Immediately after the fish are hatched they are quite helpless and tend to huddle together. When thousands of these little fry press together closely they

become suffocated, and in order to keep them apart, Green used a feather to brush them gently off the top just when they emerged from the eggs and to keep them apart later on. Attached underneath the body of the newly hatched fish is a sac, called the umbilical sac, which contains nourishment for about 30 days in the case of trout and 10 days in the case of whitefish. At the end of this period, the fish must be fed on a diet of beef liver cut fine and pressed through a very fine sieve. After 10 days of this diet, the fish can be turned loose to make their own way in the lake or river.

The above method is called the dry impregnation method, because there is no water added to the milt and spawn in the pan. When Seth first started his experiments, he had used water to mix the milt and spawn together. This was the method used by the Frenchmen, but Seth found that only 25 per cent of the eggs artificially propagated in this way hatched. On consulting a friend who was also experimenting in fish culture, Green learned that this percentage was equal to any record of fish artificially hatched. Seth, not satisfied, continued his experiments and, after a series of trials and errors, dispensed with the use of water to mix the spawn and milt. His first attempt at the dry impregnation succeeded in hatching 97 per cent of the eggs. Green kept this discovery to himself for four years while he sold the spawn for from $8 to $10 per 1,000.

Seth soon found that he had become famous. The story about a man in Rochester who was doing marvelous things with fish found its way into the New York papers. There was an almost universal ignorance about fish culture in this country; well-informed men, as well as scientists, had little knowledge about this subject. At one time, during a discussion about fish, a very inquisitive and intelligent man was told that trout eggs were hatched by putting them under a hen. The listener did not venture to express his doubts for fear that he would seem ignorant.

No sooner did the story of Seth and his fish hatching become known than suddenly trout ponds sprang up almost over night in all parts of the country. In fact, it became the fashion to raise trout. Seth's correspondence grew voluminously, and the papers and magazines were scanned hungrily for any news about fish culture. One of the early trout experimenters, Livingston Stone, reading a paper be-

fore the American Fisheries Congress in Florida in 1898, expressed the enthusiasm of the early experimenters very well:

> It seems as if we should never feel again . . . the thrill of pleasing excitement that tingled to our finger ends when we first saw the little black speck in the unhatched embryo which told us that our egg was alive. It was one of the dearest sights on earth to us then. And when the first little trout emerged from his shell and wriggled in the water, why were we so excited and elated? Was it because that little fish opened up to us a new world of promise and because we had a dim vision of the countless multitudes of living creatures that this little embryo was the insignificant forerunner of? I suppose it was something of the sort. And now, after those long years have passed and we coldly watch under a microscope, with a half scientific interest, the development of this little black spec named by scientists the "choroid pigment," we can hardly believe that such a commonplace, matter-of-fact affair, could have stirred our feelings and our imagination as it did once, when the sight and sensation were both new, and the world of promise before us was untried and unknown.

Shad Propagation at Holyoke

One day in 1867 the fish commissioners of four New England States invited Seth Green to come to the Connecticut River to undertake the work of propagating shad. Other men who had experimented with the task off and on since 1848 had failed. Nevertheless Green agreed to go, and as soon as the commissioners telegraphed that the fish were ripe, he departed for Holyoke.

The fishermen were just drawing the seine when he arrived. Seth was so anxious to get started that he would not take time to change his clothes until the impregnated roe were placed in pans brought along for the purpose. When Green, dressed in a frock coat and pants, told the fishermen what he intended to do, they, thinking it all a great joke, decided to have a little fun with him. First one handed him a female fish, then another, and another, and finally a dozen female fish all at once. While he was stripping these, they let the roe of others fall all over him. At the same time they offered to eat raw all he could hatch. Green knew what they were about, but took it all in good humor. After mixing the roe and milt of three pairs of shad, he deposited his boxes in water, hoping to keep them there until he could change his slime-coated clothes at the hotel. He was

soon back ready to work all night at his hatching boxes. Damming a creek which had its entrance at the Connecticut River nearby, he erected sub-dams and waste-gates, built his hatching boxes, and put the eggs in them.

In the meantime, the fishermen were beginning to realize that Seth was in earnest. He had told them that he was going to make shad "plenty" and "cheap." This was the wrong approach, for the fishermen, who then received a high price for their shad, feared that if Seth really could make fish plentiful, their price would be lowered. Moreover, the fishermen had become irritated by some state enactments which seemed bound to ruin their business. Reasoning that if Seth were not successful, he would not be of much use around their shores, the fishermen decided to take matters into their own hands. They closed the gates which supplied his hatching boxes, thereby causing the eggs to die; they even tore his fishing nets, although this mischief did not faze Seth, since he was adept at mending fish nets and lost no time in restoring them to good working order.

Meanwhile, Green was laboring under the belief that shad eggs could be hatched in the same way as trout eggs. Shoveling gravel a few inches deep into the bottom of his boxes, he placed the boxes where they could be readily supplied with a current of cool water. Then he put the eggs in the gravel, keeping them carefully spread, and when everything was ready he turned on a stream of water with as much force as was necessary for hatching trout. Yet he was disappointed by what he saw. The spawn rose immediately from the gravel and was washed over the further end of the trough. Realizing, then, that the shad spawn had little specific gravity and was much lighter than that of salmon, he lessened the pressure of the current. But every egg died. Seth knew something was wrong. It was clear to him that a full stream of fresh water must be supplied, but it must not be rapid; so he devised another plan. At the end of each side of his trough he heaped up a pile of loose gravel and let the water filter through. A few eggs hatched after this; but Seth noticed that whenever an egg would fall into a clear space between the gravel and become isolated from the rest of the eggs, at the same time that a steady stream of water flowed over it, the egg would hatch; but whenever the eggs became piled on top of one another or were spread over the surface, they failed to hatch.

Seth's next thought was to use boxes with wire screens. He tried every arrangement with them, fastening them first on the top, then on the bottom, then on the sides, but the only result he produced was a live fish hatched now and then amidst hundreds of dead eggs. One of the things Seth did find out was that cold water was injurious to the shad spawn and that considerable warmth was needed. Trout hatch well at 40 or 45 degrees, but from his experiments with the few live shad he managed to hatch, he found that 75 degrees was necessary.

Though he gained this knowledge, the secret to the easy hatching of the eggs was yet beyond Seth, and the time was fast slipping by. In fact, one or two more failures would bring him to the end of the spawning season, and it would probably take years before he would be able to try any experiments with shad again. Besides, the ignorant fishermen were causing the harried Green more trouble. The men whom he had engaged to help him in night fishing were very willing to accept whatever money he offered for their help, but they devised many schemes to annoy and irritate him. They made it seem as if the fish flopped across his face, or they would stumble over the boat and upset the pans containing the impregnated spawn, or they would drop the lantern into the water just at an important moment. They upset his hatching boxes whenever possible, and filled others with dead spawn. Seth was quite beside himself with dismay.

On the fifth day after he had arrived at Holyoke, Seth was still working with the boxes which had wire screens on them. While manipulating one that had the wire on the bottom, he tried to arrange it so that the eggs could be properly oxygenated, and by doing so, he accidentally tilted the box so that the front end was raised; and the stream, filtering strongly through the wire, struck the bottom of the box at an angle. To his overwhelming joy he saw the eggs which rested in the lower end rise up and seem to boil like bubbles in a tea kettle; he then raised the further end of the box, and more eggs were set in motion; he raised the box up still higher, and all the eggs boiled up madly, even though the water did not pass over the top of the box at the lower end. This action was just what Seth wanted. He then set about preparing a box with wooden floats on the sides, arranging it so that it would be held in the necessary position. The eggs safely deposited, he anchored the box in the river.

That night Green was determined that no harm should come to his precious hatching boxes. He lay down in the bushes near the shore, gun at his side, prepared for any emergency. At about midnight, he noticed that man was wading in the river and was making his way out to the hatching boxes. Seth shouted to him to stop, but the man kept running parallel with the shore. Seth followed on land and kept up with him. Finally, when he saw Seth prepared to shoot, the man came ashore and told Green that he wanted merely to see what was floating in the river. Seth informed him, none too gently, and the man went quietly away.

Another day and another night of watching went by, and soon the hours required for hatching would come to an end. At daylight on the second day, Seth went to his room. He stood for a moment looking out of the window from which he could see his hatching boxes and in which lay success or failure. Turning away from the scene which caused him so much strain and heartache, he lay down exhausted and despondent on the bed. So overtired, high strung, and nervous was he that he could not sleep. A little later one of his friends came in to tell him that it was time for him to get up. But Seth refused, saying that he was sick, that he knew he was a failure, and that he would go home. His friend gave him a glass of wine, and after drinking it, Seth felt his courage returning. He dressed, and with heavy heart waded out to his hatching boxes, gathered a phial full of the spawn, and returned to the shore. Not until he had reached the side of his friend did he dare to hold up the phial to the light. The eggs were just beginning to hatch, and very soon Seth saw the entire phial become filled with tiny semi-translucent fish. In the split second in which Seth perceived what had happened, it seemed to him as if all his dreams and desires, concentrated into this one experiment, had been fulfilled. When he finally went back to look into the box, he found it alive with minute life; except for a few dozen eggs, every one had hatched.

The change in Seth's appearance after this remarkable event was amazing. Years later Livingston Stone, who was assisting Seth at Holyoke, likened Seth's feelings when he saw the newly hatched shad to those of General Sheridan when the tide of battle turned at Winchester. By these results Green had definitely established the fact that

shad could be produced with far less trouble and more certainty than trout or salmon; for only 33 hours after Seth had deposited the eggs they showed life, and they hatched in from 46 to 60 hours, whereas salmon eggs take from 70 to 140 days to hatch. Moreover, while there is a loss of nearly 10 per cent in the artificial propagation of both salmon and trout, even when the dry method is used, with shad the loss is small and insignificant.

But there were other difficulties which Seth had to meet before he could feel that the work at Holyoke was completely successful. He found that, when the minute fish were placed in the river, almost every small fish in sight fell upon the young shad and devoured them. He found, for example, upon opening a small minnow an inch long that it had eaten a dozen small shad. After several trials, Seth discovered that shad encounter enemies no larger than themselves in shoal water and, in order to escape them, hurry out to the deep current, where they are unseen by the larger fish, because of their minuteness, and can go on their way undisturbed. Accordingly, each evening Green placed the shad which he had hatched during the day into midstream, in order to give them a start of twelve hours of darkness over their enemies. The small fish descended the river with their heads against the current, thus gaining strength by struggling against it.

Seth had placed 50,000 to 100,000 spawn in the hatching boxes at one time, and he had found that in some instances 999 in a 1,000 hatched. In this way he hatched from 2,000,000 to 6,000,000 a day and, by the time he was ready to leave Holyoke, he had placed about 40,000,000 shad in the Connecticut River. In the spawning reason of shad in 1868, Seth returned to Holyoke and produced about 20,000-000 of the shad fry daily. By the end of 1868, 60,000,000 shad had been placed in the Connecticut River. Seth decided not to produce any more shad in 1869, since he was eager to see the results of the first two years' work. In 1870 there was such an abundance of shad that the Connecticut people were overjoyed, for there had not been a haul like it in 20 years. In fact, it was said that there were 60 per cent more fish in 1870 than in 1811, when the largest shad haul in the history of the Conecticut River had been made.* Before Seth's remarkable work,

*It is only proper to add that Professor S. C. Bishop of the University of Rochester biology department, a modern pisciculturist who has kindly read this paper and proffered numerous suggestions, considers it extremely doubtful that "Green's plantings of 1867-68 had much to do with the run of 1870."

shad had been selling for $40 a hundred; now shad become so plentiful that they sold for as low as $3 a hundred.

Despite the beneficial results which the four New England States —Massachusetts, Vermont, Connecticut, and New Hampshire — received from Seth's hard labor, they each contributed a little less than $50, a total of almost $200, for his work and expenses. Seth became bitter about the low value thus attached to his work. Actually, it was neither money nor fame that Seth sought; he was genuinely interested in restocking the depopulated lakes, streams, and rivers of the United States, so that the mass of people could buy nutritious fish at low prices. He had told a reporter of the New York Evening Telegram: "I have been told by fishermen that they did not want fish made more plentiful. They said if fish were scarce they could make as much money and would not have to handle half as many fish. But I said to them: 'It would be a great help to the mass of people.' They told me to 'let the masses take care of themselves—we have to.' "

Shad Propagation Elsewhere

When Green realized the illimitable possibilities he had achieved in Connecticut, he turned his attention to his home territory. The waters of New York State were fast becoming depleted of fish, and he saw that within a few years' time they would become barren, for, he maintained, "fish are local. They have a home and they will not leave it until they are taken, and when they are all taken, there will never be any more in that place until they are put there." It occurred to him that this problem could be solved only by an interested group of people such as a fish commission. He thereupon set to work to encourage several men whom he knew had had the fishing problem in mind. One of these men was the Hon. Horatio Seymour, ex-Governor of New York State, and the other was the Hon. Robert B. Roosevelt. The latter petitioned the legislature for the creation of a state fishing commission, and in the spring of 1868, Governor John T. Hoffman appointed Green, Roosevelt, and Seymour fish commissioners. Their duties were to examine lakes and rivers and to bring about a substantial increase in the production of fish in the waters of New York State; the amount provided for this work was $1,000.

Green began by restocking the Hudson, selecting as his site for work the right bank of the river, about four miles above the town of Coeymans. The fishermen along the shore jeered at the famous fish culturist, believing that he was an imposter. The farmers nearby refused to allow Seth to enter their homes, because they feared he was insane, so Green had to go to Coeymans for a night's lodging. Seth also found that he was being subject to various questions by at least a dozen men who seemed to look at him quizzically and appraisingly. Several years later James Mull, who owned the fishery where later the state erected a shad-hatching establishment, recalled that he had sent several men over to where Green was working, in order to see what kind of person he was. When the men returned to report their findings to Mull, a few of them told him that while Seth might have been insane, he was no fool.

From the time of the Commission's formation in 1868 until the year 1875, the fish commissioners leased enough ground at Caledonia for a hatchery, obtaining this right from A. S. Collins who then owned the trout hatchery which Seth had begun in 1864. The commissioners at first confined their hatching operations to salmon trout and whitefish, the distribution of mature fish, and the hatching of shad in the Hudson River. In 1870 Seth resigned his position as commissioner and was promptly appointed Superintendent of Fisheries. George G. Cooper of Rochester was then made commissioner in Green's place. Five years later, the state bought the hatchery from Collins, thus enabling the commissioners to confine their work to the distribution of brook trout for restocking public waters. Every year the commissioners placed a notice in the newspapers to the effect that they would receive from December 15 to March 1 orders from anyone interested to obtain fish for stocking public waters. That is, a person living near a body of water which had had an abundance of fish but which was becoming depleted might write to Green for advice in this matter. He would reply, giving pertinent instructions and sending the applicant a blank, with directions and information regarding expenses, which involved his travelling costs from Caledonia and the express charge on the cans containing the fish. The state furnished the fish free of charge.

In May, 1868, Seth decided that there was not sufficient concern felt in regard to the depleted condition of the Potomac River. To attract the public's attention, Green went to General Spinner's home in

Washington to demonstrate how quickly and easily shad can be hatched. He placed some shad spawn in a tumbler, and in a few hours the glass was filled with minute life. From there he was accorded the honor of using a room in the Treasury Building to demonstrate further how simple but important was his work. In this room he hatched 1,500 shad in a salt box. A few months later the way was prepared for him, and Seth was able to stock the Potomac with white perch, striped bass, herring, sturgeon, and catfish. From there he went on to the Susquehanna and Delaware Rivers in order to arouse the interest of the fishermen to the necessity of propagating shad. Seth continued his trip South, where the Rappahannock, James, and York Rivers were badly depleted, and deposited many thousands of shad in these waters. Going still further South, he reached Augusta, Georgia, at the banks of the Savannah River. In fact, Seth helped to restock practically all of the principal Southern streams.

Transporting Fish Eggs

New problems were constantly besetting Green. An especially vexing one was that of transporting fish eggs from one part of the country to the other. He and his brother Monroe, who had continued his help to Seth for many years, had been experimenting on this problem for a very long time, seeking to cut the loss of fish eggs as well as the excessive care required. The usual procedure for collecting eggs to be hatched at Caledonia was as follows. The salmon trout were stripped of their eggs off Cape Vincent Lake in the autumn. Green's men, stationed along the coast at various points wherever there were fisheries, collected the spawn and then sent on the impregnated eggs to Caledonia in large cans filled with water. It was imperative to have a man watching the spawn constantly while the cans were being collected, one every day or two, until they were sent on to Caledonia. Monroe eventually devised an ingenious invention. It consisted of a large box containing trays capable of holding at least 150,000 eggs. As soon as the eggs were artificially impregnated, they were placed immediately on damp cotton flannel and inserted into the trays. Once the eggs were thus placed in the box, no attention was required. Only one man at each station was needed to collect the boxes containing the spawn, and at the end of the spawning season all of the boxes were

sent to Caledonia. In the meantime the eggs developed, and by the time they reached Caledonia a good many had hatched. Thus as a hatching apparatus, Monroe's invention was complete in itself. Another good feature about this invention was the fact that the boxes weighed far less than the cans filled with water and eggs; one of the boxes when filled weighed but 50 pounds, while a can filled with water and eggs weighed 120 pounds. The amount of eggs that could be easily carried in cans equaled one-fifth as much as could be carried in boxes. Moreover, by the old method of carrying spawn in cans the loss of the eggs was far greater than that carried in boxes, wherein hardly more than one egg in a thousand failed to become a fish. By this new process, the spawn could be shipped to any part of the country for as long a time as four or five months.

Seth's mail was voluminous. He received letters from all parts of the country, and the generous Seth replied to the numerous questions in detail. One day in the spring of 1871, Green received a letter with an unusual request. It was written by Thockmorton and Redding, fish commissioners of California, asking Seth what he thought of the idea of taking young shad to California. Seth answered that the ova could not be shipped, owing to the time element, but that it might be possible to ship newly hatched fish while in the stage of dependence on the sac that is provided as food. Still, wrote Green, the chances of transporting them successfully were poor, since a wide strip of alkali country lay across the route to California, making it difficult to get a change of water whenever necessary. Yet, despite these objections, Seth was willing to take the chance, since he thought the experiment worth trying. He wrote to the California commissioners that if they would send the money necessary for travelling expenses for himself and for an assistant, he would furnish the cans and fish free of charge. A few weeks later, Seth received the money.

On June 19, 1871, the quiet, unassuming Green started out at six o'clock in the morning from Mull's Fishery, ten miles below Albany, on the Hudson River, for California. He had placed in four 8-gallon milk cans 12,000 young shad which had been hatched the night before at the fishery under the supervision of the New York State Commissioners. Arriving at Cleveland the next morning, he put 200 shad in Lake Erie and changed the water. The fish were quite lively and showed no signs of sickness. At Chicago, Seth found the

water of Lake Michigan quite satisfactory for the shad and deposited 200 more fish in that lake. Changing the water, Seth started out once again with the cans of lively fish for California. When he reached Omaha, the fish were still in good condition, but Seth was dismayed to find that, after testing the water in a tumbler in which a few fish were placed, it would be impossible for his little charges to live on it. To make matters worse, Seth knew that he would not be able to get a full change of water for at least 400 miles. As he himself observed, "It was a blue time for me. I would look at the little helpless fellows; they were suffering, and so was I. I had brought them into the world, and would not see them suffer if it was possible for me to help them."

It was not long before Seth found a way out of his difficulty. Since there were tanks filled with good water for the passengers in all of the cars, it occurred to him that it might be a good idea to use this water for the fish. So he walked through all the cars with his little tin pail, stopping at each tank for water. Happily, he missed the porters, who soon began to discover, however, that all the water was being taken by someone. They had noticed Seth with his little tin pail, but they had not seen him take any water. Sensing something peculiar about the stocky man, with a long beard, carrying a tin can on his arm, the porters quickly went to the baggage room and told the man in charge of baggage what had happened and whom they suspected. When Seth returned to the baggage room, where he kept his little fish, the baggage man became furious and started toward him, hand raised as if to strike him. But, noting Green's stocky build, he thought better of starting a fight. When he cooled down a bit, Seth told who he was and where he was bound for. Seth explained how necessary it was for the young fish to have good water, and the man grew sympathetic. Then Seth shook hands with him, and the man closed his hand tightly and put it in his pocket. He asked Seth if he could do anything for him. Seth merely pointed to his pail, whereupon the baggage man snatched it and returned almost immediately with it full of water. As soon as Seth emptied it, the man took it and brought it back refilled. A few moments later a porter came in. Seth shook hands with him, and the same procedure occurred: Seth pointing to the pail, and the pail filled to the brim returning immediately, as if by magic. More porters came and more hands were shaken and more pails brimming full going and coming. Then as the pisciculturist later

remarked, "My little fish began to stop rolling up their big eyes at me and I was happy."

But Seth's difficulties were not over. Until he reached the Laramie River, where he had obtained a full change of the water, he was beset by the fearfully hot weather. It was midsummer, and Seth still had several hundreds of miles to go with his young shad, which had by now completely absorbed the contents of the sac attached to their bodies and were ready for such minute animalculae as could be found in lakes or rivers. Moreover, the thermometer continued to register 100 degrees in the shade from nine o'clock in the morning until four o'clock in the afternoon. To keep the temperature of the water down below 82 degrees, Seth kept putting ice in the water, a very little at a time.

On the twenty-sixth of June, after seven days and nights of careful watch over the young fry, Seth arrived in Sacramento, where he was met by the California fish commissioners, Redding and Smith. Seth immediately examined the river and found it too roily for the fish to live in. It occurred to him then that if he went 275 miles up the river near its source the river might be far more satisfactory for the young shad. Accordingly, Green and the California Fish Commissioners left Sacramento the same afternoon and arrived at the river's source at ten o'clock that night. When Green's belief was confirmed by tests of the water, he deposited about 1,000 shad in the Sacramento River. Although this was the first time that any shad had found a home in a tributary of the Pacific, they took to the river as if they had always been there, for here they were able to get the insects and animalculae so necessary for their sustenance; here also was an abundance of gravelly banks upon which they might cast their spawn. Green also tested the shores of the Pacific and found there many of the same insects and minute animals that inhabited the shores of the Atlantic.

Thus Green was completely satisfied that his experiment would be successful, which proved to be the case; for on April 1, 1873, S. R. Thockmorton, one of the California Fish Commissioners, wrote to Professor Baird, the United States Commissioner of Fisheries, that he had purchased the first shad ever taken on the Pacific Coast. It had been caught in a trap in the Linsoon Bay, a branch of the harbor of San Francisco. When Thockmorton obtained the fish, he placed it in al-

cohol for presentation to the Academy of Sciences of the State of California. It was a male fish 1 year, 9 months, and 12 days old; it was 17 inches long, and weighed 3 pounds.* In the summer of 1873, 2 more shad were found in the same locality; the following year a few more were seen. But in the spring of 1874, the California legislature passed a bill prohibiting the taking of shad until 1877. The year 1878, however, brought shad in the San Francisco markets selling for $10 each. Nearly 20 years later, this fish was so plentiful on the Pacific Coast that it was incumbent upon the fishermen to limit their catch, in order to prevent overstocking the market.

After the California expedition, Seth turned his attention to the artificial impregnation of fish other than salmon trout, shad, and whitefish at the Caledonia hatchery. He now crossed striped bass with shad, shad with herring, brook trout with herring, brook trout with California salmon, salmon trout with whitefish, and European trout with American brook trout. But he featured brook trout especially in the State hatchery at Caledonia, which he found could thrive in our own waters.

Recognition

By now Seth Green's name had spread far and wide, from coast to coast, and throughout the world. A Westerner visiting in Rochester asked a *Post Express* reporter, one day, whom he considered the best known Rochesterian. The reporter mentioned several names, but the stranger answered: "No, your best known man is Seth Green. Why, he is a thousand times more famed out of Rochester, I judge, than in it. The newspapers in other parts of the country have something about him every week or two, but I see no extracts of the same sort from the Rochester papers." About the same time it was reported by a Rochesterian who had been travelling in Germany that he had met there a native German who was especially cordial to him because he (the Rochesterian) had come from the same city in which Seth Green was born and was living. The same German brought forward his two sons to be introduced to the Rochesterian, so that they might have the honor

*Again Professor Bishop wonders whether this not in part a good fish story as the average shad weights two pounds at three years, and few if any have reached three pounds in one year and ten months.

of meeting and talking with one who had known Seth Green. Seth was known even in New Zealand and Australia, as well as in France and Germany, since he was the first to have successfully packed and shipped fish eggs to those countries.

Early in 1873 Congress passed a bill appropriating a sum of money for an American exhibition to be sent to Berlin in April of that year for the Berlin Fish Exhibition. It also provided that money should be appropriated for the construction of an iron fish-hatching steamer of 500 tons. The vessel, duly constructed, was the first ship of its kind ever built; it was equipped with the most advanced appliances for fish catching and for their artificial propagation. Professor Baird, the United States Fish Commissioner, took this ship to Berlin and had on board the American exhibit of fisheries.

Seth was shown the appreciation of this country and that of France and Germany in the form of tangible awards. In 1872 and again in 1875 the Société Impériale d'Acclimatation of France sent Seth a solid gold medal for his work in pisciculture. In the early autumn of 1876, the United States Centennial Commission gave Green a certificate of award at the International Exhibition held at Philadelphia. And in 1880, the German Fishermen's Club at Berlin awarded Seth a gold medal for his work in fish culture. When he returned to Holyoke in 1874, he was extremely pleased to see how the people flocked around him. When speaking of this incident, he remarked that he was made so happy by this genuine outburst of appreciation that he forgave everyone who had misused him, including the four New England States, who paid him a little less than $200 for his hard labor in 1867.

Green carried on an extensive correspondence with pisciculturists of other countries in regard to the various methods of artificial propagation. He wrote many articles for magazines and newspapers and served as editor of the sports department of *The First American Angler*. In 1870 Green and Collins published the work, *Trout Culture*; nine years later, the Hon. Robert B. Roosevelt collaborated with Seth on *Fish Hatching and Fish Catching*; and in January, 1888, Green himself wrote *Home Fishing in Home Waters*.

One of Seth's greatest delights was to go on fishing trips with his friend, Robert B. Roosevelt. They would often start out to investi-

gate the practicability of stocking a few rivers with certain kinds of fish, and would end up with a pleasure trip on a yacht, or more often on Seth's own vessel. Every year Seth and Roosevelt would take a cruise on Great South Bay. While reminiscing about his youth, Seth said one day, "No, I do not want to be a boy again . . . I have my reasons for so feeling, and one is, my friend Roosevelt would not know me, and if he did he would not recognize me. I have been shooting and fishing and yachting with him for a number of years and have had many good times. Often while we were yachting we have run aground, and then Bob would sing out: 'Come, Seth, let's take a bath.' "Then to see two old fellows weighing over 200 pounds each, stripped off, and while Bob carried a 100 pounds of anchor, I was 4 rods behind him dragging the chain, and then planting the anchor 30 fathoms from the boat we would heave her off. No, no more boy for me . . . "

But one of these trips with his friend Roosevelt was to prove disastrous. In 1882 Seth went with Robert on a yachting and fishing trip off the coast of the Carolinas and contracted typhoid pneumonia. Seth never fully recovered from this disease, although he was able to carry on his work. And one day in January, 1888, Seth and his son William went to Professor Ward's museum to look at a devil fish. As they left the grounds, the cutter in which they were riding overturned. Seth fell out on his face, still holding firmly to the reins, and when the horse started, the force of the movement severely hurt the muscles of the aged man's back, causing him to be confined to his house until his death. Unfortunately, Seth had become quite senile, and this condition, together with the accident, hastened his end in August, 1888.

Bibliographical Note: Much of the information for this article has been gleaned from Seth Green's Scrapbook begun in 1874 and continued beyond his death by a member of the family. A photostatic copy of this scrapbook, together with a file of letters and clippings and typed manuscripts on Seth Green, has been presented to the Rochester Historical Society by Mr. Howard C. Dana, formerly the chairman of a Seth Green Memorial Committee. Additional material has been found scattered through various collections in the Local History Division of the Public Library. A biographical sketch of Seth Green appears in the *Dictionary of American Biography*.